

## The soils, flora, vegetation and vertebrate fauna of Chatham Island, Western Australia

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### Abstract

The biological results of the first scientific survey of Chatham Island, of area 69 ha and maximum height 186 m, are presented. The two main soil types and two intermediate kinds are described. The island supports 46 vascular plant species (of which only 4 are alien), 4 species of lizards and breeding populations of the Little Penguin, Little and Flesh-footed Shearwaters, Welcome Swallow and Silvereye. A species of native rat occurs. The only known extant population in Western Australia of the fern *Asplenium obtusatum* occurs on the island.

### Introduction

Between 11 and 22 May 1975 we visited Chatham Island in order to trap Silvereyes for genetic studies. Responsibility for the research carried out was as follows. Five mist-nets were operated for a total of 360 hours in a representative 4 ha area (IA) in which also a quantitative study of habitat structure and plant diversity was made (IA and JRW). Plant specimens were collected from this area as well as over the whole island and notes on the plant communities were made (IA). Soil profiles were dug at various sites and detailed descriptions were made (JRW). Several hours on two nights were spent noting seabirds coming ashore to roost (IA and JRW). This report presents annotated lists of the flora and vertebrate fauna, part of the quantitative vegetation survey, as well as an analysis of the soil types.

### Physiography

Chatham Island (116°30'E, 35°02'S) lies west-southwest of Walpole, on the south coast of Western Australia, and has an area of 69 ha (calculated from aerial photograph). The island rises nearly perpendicularly from the sea to an elevation of 186 m near its southern end, and slopes gradually to the north. Seen from the east or west the island has a wedge-shaped appearance (Fig. 1). The island measures approximately 1.2 km by 1.0 km at its widest point. It lies 1.1 km from the mainland. The depth of the intervening strait is 37 to 46 m. The island was separated from the present mainland 11 000–12 000 years ago. To

the immediate east and south of the island depths range from 46 to 66 m (Admiralty Chart No. 1934 and D. Beale pers. comm. 1975).

The island is a granite-gneiss dome, of a type which is common in Western Australia. The resistance of such domes causes them to stand out as bosses often forming headlands, islands or peaks inland. On the southern side and near the summit very extensive areas of bare rock occur (Figs. 2, 3). A small area of limestone cliffs is present in the northwest corner. The average annual rainfall is probably similar to that of Walpole, and would be 1 400–1 500 mm.

Suitable landing sites are in bays on the north and west sides, but landing is difficult at all times owing to the swell. We landed in the northern bay.

### History

The island was named Cape Chatham by G. Vancouver on 26 September 1791, after the Earl of Chatham. Vancouver's ship reached no closer than about 20 km and with poor visibility the island must have appeared as a conspicuous cape. Flinders in 1801 established its insular nature. William Nairne Clarke in his epic voyage from King George Sound to Nornalup and beyond in 1841 found Chatham Island on 6 March to be full of 'Sooty Petrel' burrows. He also found fur seals there.

The island has received little interference from man, although a fire was noted in the 1960s (D. Beale pers. comm. 1975). Small cairns at and near the summit show that the island has been landed on this century, probably by fishermen.



Figure 1.—View of Chatham Island from southwest.

### Soils

There is only approximately 40% soil coverage on Chatham Island, most of the surface being bare rock. Thus, most of the soils are extremely shallow (0-40 cm) and overlie granite slabs and boulders. In the northeast sector, however, much deeper soils occur on the more gentle slopes and there has also been considerable movement of weathered parent material down-slope. This sector also exhibits marked differences in soil type due to the small outcrop of limestone (Fig. 2).

With the exception of isolated pockets, mainly near the summit of the island, all the soils have been extensively burrowed by seabirds to depths of up to 90 cm. The resulting soil disturbance and faunal wastes have clearly had a marked effect on soil formation.

The soils of Chatham Island were surveyed over a two day period, initially by two non-randomized transects across the major vegetation study area and later by a series of non-randomized soil pits located throughout the remainder of the island. Each profile examined was described *in situ* but pH, colour (Munsell soil colour chart) and texture were determined in the laboratory. A total of 15 soil pits and approximately 10 shallow inspection pits were examined. A generalized map of soil types is shown in Fig. 2.

### Soils overlying granite

*Peats.*—Chatham Island experiences cool, wet conditions during most of the year due to its geographical location and highly exposed position. These climatic conditions have undoubtedly assisted in the development of shallow peats over most of the rock surface. In the deeper pockets of soil there is slight profile development (Appendix) and in some parts of the northeast sector there is clear evidence of ironpan formation, especially towards the limestone outcrops. The degree of *in situ* rock weathering within and to the base of soil profiles varies markedly from site to site and is generally associated with joints and discrete boulders.

Generally, the soils have a reddish-black surface horizon containing much organic matter and plant litter, and with an acidic pH in the range 4.0-5.0. In the deeper, more developed soils, there is a slight increase in fine clay with depth and overall a decrease in the amount of semi-decomposed plant litter. Feathers and other organic detritus occur in burrows at any depth and tend to complicate the rather subtle soil changes between horizons. There is usually a decrease in pH with depth to values as low as 3.5.

Many of these soils have poor drainage and the shallower soils in particular have a mass of plant roots and impeded lateral water movement at the soil/rock interface.

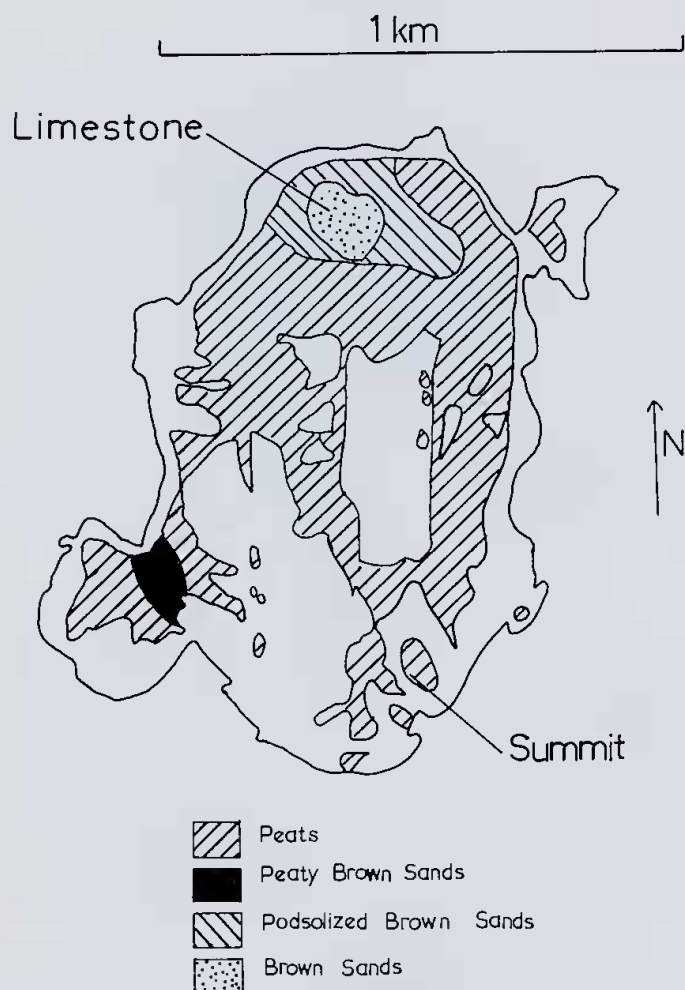


Figure 2.—The soils of Chatham Island. White areas represent (at this scale) bare rock.

#### Soils associated with limestone

**Brown sands.**—In the limestone area there are pockets of deep brown sandy soils occurring between exposed limestone outcrops. These soils show little horizon differentiation and are of neutral pH (6.5). Roots (*Rhagodia*) occur throughout the profile to depths of at least 60 cm but there is little surface accumulation of organic litter whether under *Poa* or *Rhagodia*.

Immediately downslope of the outcrops similar deep dark brown sands occur with a more marked brightening in colour (10 YR/4/6) at about 60 cm. These soils are alkaline (up to pH 7.9) with limestone fragments within the profile.

The brown sands are very freely drained.

#### Intermediate soils

**Peaty brown sands.**—This soil type occurs in a small area in the southwest sector, co-incident with the only area of *Atriplex* on the island (Fig. 3). It consists of a shallow brown sand (up to 60 cm) overlying granite, but with varying degrees of peaty surface horizon. Although there are no local outcrops of limestone, a large granite boulder nearby has remnant limestone attached to its underside. It

is possible that this soil is a relic deep brown sand originally developed from limestone but subsequently truncated and now supporting peat formation in the surface horizon.

**Podsolized brown sands.**—This soil occurs in a transitional zone between the main limestone outcrops and the granite exposures. It contains a purplish-black (5 RP/1.7/1) iron-rich zone with varying degrees of induration and iron pan formation towards the interface with a bright brown (7.5 YR/5/8) underlying sand. The pH of these two horizons is extremely low (3.2–3.4) despite the occasional presence of both granite and limestone boulders mainly in the upper part of the profile.

#### Flora

In the following annotated checklist of vascular plant species, the percentage frequency of plant species found in 50 randomly distributed quadrats in the 4.0 ha plot is indicated. An asterisk denotes naturalized alien species.

##### ADIANTACEAE

*Cheilanthes tenuifolia* (Burm.f.) Sw. (2%). Widespread on thin soil over granite slabs.

##### ASPLENIACEAE

*Asplenium obtusatum* Forst.f. Small clumps (<1 m<sup>2</sup> area) of this vigorously growing fern were found in only two places at the south end. The first was under boulders c. 180 m above sea level and the second was in a valley at the south end c. 100 m above sea level. This record is the second for the State. It appears that the first record (on Breaksea Island, 1866, where collected by G. Maxwell) refers to a population that is now extinct as IA specifically searched for the species there in August 1975. This species occurs also in New South Wales, Victoria and Tasmania, where it is not a rare species (Wakefield 1955).

##### POACEAE

*Poa australis* R.Br. (74%). See Fig. 3 for distribution.  
*Sporobolus virginicus* (L.) Kunth.  
 \**Ehrharta longiflora* Sm. (16%).  
 \**Aira caryophyllea* L.

##### CYPERACEAE

*Carex preissii* Nees. Found fruiting; only near sea level.  
*Scirpus nodosus* Rottb.  
*Lepidosperma gladiatum* Labill.

##### CENTROLEPIDACEAE

*Centrolepis* aff. *strigosa* (R.Br.) R. & S. Material is sterile. Rare; found on thin soil over granite slabs.

##### JUNCACEAE

*Juncus pallidus* R.Br. One clump only.

##### LILIACEAE

*Chamaescilla corymbosa* (R.Br.) F. Muell. (4%). Present as green fleshy projections from thin soil layer over granite.

##### ORCHIDACEAE

*Cryptostylis ovata* R.Br. Seen only in *Agonis marginata* and *Melaleuca microphylla* forest near summit.  
*Pterostylis vittata* Lindl. Rare.

##### CHENOPODIACEAE

*Rhagodia radiata* Nees. See Fig. 3 for distribution. A few fruits noted.  
*Atriplex cinerea* Poir. On west promontory only.  
*Threlkeldia diffusa* R.Br. On limestone only.  
*Salicornia blackiana* Ulbr. On west promontory only.

# AIZOACEAE

*Carpobrotus virescens* (Haw.) Schwantes (8%). See Fig. 3 for distribution.

# BRASSICACEAE

*Lepidium foliosum* Dcav. Amongst *Poa* tussocks.

# CRASSULACEAE

*Crassula macrantha* (Hook.) Diels (2%).

# PITTOSPORACEAE

*Sollya heterophylla* Lindl. In flower.

# GERANIACEAE

*Pelargonium australe* Willd. (2%). On thin soil over granite, usually with *Cheilanthes* and *Trachymene*.  
\**Geranium molle* L.

# RUTACEAE

*Boronia alata* Sm.  
*Chorilaena quercifolia* Ertl. (6%).

# RHAMNACEAE

*Spyridium globulosum* (Labill.) Benth. Rare. A few bushes near south end.

# DILLENIACEAE

*Hibbertia cuneiformis* (Labill.) Gilg. In flower.

# MYRTACEAE

*Agonis marginata* (Labill.) Schau. One of two tree species on island. Flowers noted. See Fig. 3 for distribution.

*A. flexuosa* (Spreng.) Schau. Rarely exceeding 1.5 m in height probably owing to the exposed positions in which it grows. See Fig. 3 for distribution.

*Melaleuca microphylla* Sm. The rarer of two tree species on island.

*Thryptomene saxicola* (A. Cunn.) Schau (6%). Flowers noted. Widespread, particularly around granite slabs.

# HALORAGACEAE

*Haloragodendron racemosum* (Labill.) Orchard. Very few flowers. See Fig. 3 for distribution.

# APIACEAE

*Apium prostratum* Vent. Near sea-level.  
*Trachymene anisocarpa* (Turcz.) Burt (52%). Widespread through tussockland and on thin soil over granite.

# EPACRIDACEAE

*Leucopogon parviflorus* (Andr.) Lindl. Seen only in valley at south end.  
*Andersonia sprengelioides* R.Br. See Fig. 3 for distribution.

# PRIMULACEAE

*Samolus repens* (Forst.) Pers. Near sea-level.

# LOBELIACEAE

*Lobelia alata* Labill. Flowers noted. Near sea-level only.

# ASTERACEAE

*Olearia axillaris* (DC.) F. Muell. ex Benth. A remarkable form in which the leaf shape and arrangement resemble those of *Westringia dampieri*.  
*Senecio lautus* Forst. f. ex Willd. (4%). Near sea-level and throughout tussockland.

*Calocephalus brownii* (Cass.) F. Muell.  
*Actinobole uliginosum* (A. Gray) Eichler. A few flowers noted.

*Gnaphalium luteo-album* L.  
*Helichrysum bracteatum* var. *albidum* DC. A few flowers noted.

\**Hypochaeris glabra* L. One rosette found.  
sp. indet. (seedling) possibly *Parietaria debilis* Forst. f. (10%).  
sp. indet. (seedling) (2%).  
sp. indet. (seedling) (2%).

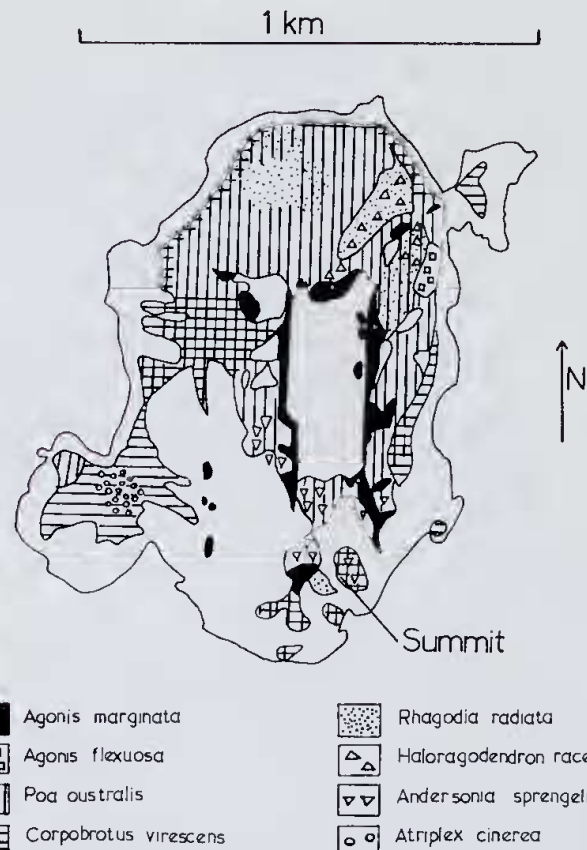


Figure 3.—Vegetation map of the island. White areas represent (at this scale) bare rock.

## Vegetation

The main plant communities on Chatham Island are *Poa australis* tussock grassland, *Carpobrotus virescens* herbfield, *Rhagodia radiata* low closed-shrubland, *Agonis marginata* low closed-forest, and *Andersonia/Thryptomene/Cheilanthes* lithic complex. (See Fig. 3).

1. *Poa australis* tussock grassland. This community is the most extensive. Most cover is due to large tussocks (1 m high) of *Poa australis*, in between which *Trachymene*, *Senecio*, *Lepidium*, *Crassula*, *Ehrharta* and various small seedlings occur. On the western slopes of the island, especially at low altitudes, much *Carpobrotus* is present.

2. *Carpobrotus virescens* herbfield. This community is found on the two promontories and along the edges of the island. Near the summit *Carpobrotus* grows in windswept crevices containing very shallow soils. Associated genera are *Lobelia* (sea-level only), *Senecio*, *Sporobolus*, *Atriplex*, *Salicornia* (last two on west promontory only), *Samolus*, *Scirpus*, *Lepidosperma* and *Cheilanthes* (this last around rock slabs away from sea-level).

3. *Rhagodia radiata* low closed-shrubland. Near the limestone cliffs this species forms almost pure stands, with height not exceeding 1 m. Elsewhere *Haloragodendron* becomes codominant. In the valley at the south side *Apium*, *Boronia*, *Hibbertia*, *Chorilaena* and *Olearia*, amongst others, occur with *Rhagodia*.

4. *Agonis marginata* low closed-forest. Small stands of this species occur only in crevices with deep soil, where they are stunted. In valleys edged by near vertical granite slopes the species reaches 6 m. Considerable runoff must ensue from such places. Associated shrubs are *Melaleuca*, *Hibbertia*, *Chorilaena* and *Thryptomene*.

5. *Andersonia/Thryptomene/Cheilanthes* lithic complex. "Lithic" refers to the habitat of these plant species; they occur in thin layers of soil over granite or in small soil-filled joint lines in granite. On the plateau around the summit the first species occurs in cushion-like form and *Thryptomene* is a windblown bush no higher than 30 cm. *Thryptomene* occurs with *Cheilanthes* elsewhere around slabs of granite or on thin soils over granite over most of the island.

## Vertebrate fauna

### Amphibians

None were noted. Tadpoles were specifically searched for in the many pools of rainwater on the plateau leading to the summit.

### Reptiles

Four species of lizards were noted. Snakes are absent.

*Phyllodactylus marmoratus*. Common under slabs of exfoliated granite.

*Ctenotus labillardieri*. One was found in soil under a *Poa* tussock.

*Hemiergis peronii*. Four were found under *Poa* tussocks.

*Egernia kingii*. The most abundant lizard species. It was found from sea level to summit excluding large expanses of rock devoid of pockets of vegetation or slabs. All specimens were black with prominent yellow markings.

### Birds

*Eudyptula minor*, Little Penguin. Very common and found along all accessible parts of the coast (i.e. the north and west parts) in *Carpobrotus* and *Poa*. They were recorded as coming ashore 45 minutes after nightfall and leaving about 45 minutes before first light.

*Diomedea melanophrys*, Black-browed Albatross. Two were seen offshore near the west and north sides respectively.

*Puffinus assimilis*, Little Shearwater. Only a few were seen, above the campsite amongst *Poa* tussocks. Only one skull was found.

*P. carneipes*, Flesh-footed Shearwater. This presumably is the 'large Sooty Petrel' found on the island in 1841 by Nairne Clarke. For the time of the year, the birds were surprisingly common. On a walk around the northern parts of the island one night we saw one adult every 15-30 m. No chicks were seen but during the day noises from underground were attributed to this species. Dozens of skulls were picked up over the island.

*Sula bassana*, Gannet. Three followed the boat as we approached the island.

*Ardea novaehollandiae*, White-faced Heron. One, presumed vagrant, was seen most days around the island.

*Haliaeetus leucogaster*, White-breasted Sea-eagle. One pair was seen most days, but they were never seen perched. No nest was found.

?*Falco peregrinus*, Peregrine Falcon. On 21 May one bird was seen briefly near the northern end, and IA's field notes are 'One falcon with black head; larger than Kestrel but smaller than Brown Falcon'.

*Falco cenchroides*, Kestrel. One pair was present. One bird was seen perched on an inaccessible ledge once; no nests were found.

*Haematopus fuliginosus*, Sooty Oystercatcher. Foraged on the more gentle granite slopes leading into the sea. Usually two or three birds were visible from the campsite. The maximum number of birds seen together was five.

*Larus novaehollandiae*, Silver Gull. Occasionally present at the campsite. Maximum number seen was 20. There was no evidence of breeding.

*Sterna bergii*, Crested Tern. One was seen fishing off the landing place on 17 May.

*Dacelo novaeguinae*, Kookaburra. One bird, presumed vagrant, was heard and seen in *Agonis marginata* scrub on 19 May at an altitude of c. 100 m.

*Hirundo neoxena*, Welcome Swallow. Common. Maximum number of birds seen at one time was 35. Two old nests were found in a cave on western side of island. The very spacious cave on the eastern side, which is unfortunately inaccessible, probably contains many nests as Swallows were seen to fly in and out of the cave.

*Petroica multicolor*, Scarlet Robin. One male, presumed vagrant, was netted, banded and released on 12 May.

*Zosterops gouldi*, Silvereye. Common over the whole of the island, but mostly seen in *Rhagodia* bushes. However few fruits were available so the birds were probably mainly eating insects. One hundred and thirty-two feeding actions were recorded, distributed as follows: 68% on *Rhagodia* leaves, 23% on *Haloragodendron* leaves and 9% amongst foliage or flowers of *Agonis marginata*. Thirty-four birds were netted, banded and released. An old nest was found in an *Olearia* bush, 1 m from the ground, at an altitude of c. 100 m.

### Mammals

*Rattus fuscipes*. These were common around the boulders near the campsite, but none were noticed elsewhere. Several drowned in a bucket of water and were donated to the Western Australian Museum.

No mice, rabbits, goats, macropods or seals were noted. Fur seals occurred on the island in the past (Nairne Clark 1841; Cumpston 1970, p. 91). Seals are occasionally recorded at Windy harbour, 50 km north-west of Chatham Island (D. Beale, pers. comm. 1975).

## Discussion

Despite the shallow nature of the soils on Chatham Island some interesting aspects of soil formation can be observed. The dominant climatic influence is undoubtedly a cool moist condition prevailing for most of the year. This condition is due both to rapid surface runoff from bare rock surfaces on the island and to the exposed position of the island.

In general there is little correlation between vegetation boundaries and soil distribution. There would probably be better correlation on the mainland. On Chatham Island, virtually all soils are so disturbed by the burrowing habits of fauna that effects of vegetation on soil formation are minimized. Although no chemical analyses were performed on the soils it is predicted that their nutrient status will be relatively high due to excreta and other faunal wastes deposited in and around burrows.

The most recent and detailed soil survey close to Chatham Island is that of McArthur and Clifton (1975) in the Pemberton-Mt. Chudalup region, located about 30 km to the northwest on the mainland. The peats on the island are probably representative of the *Chudalup association*, whereas the other soils discussed clearly belong to the *d'Entrecasteaux association*.

The flora and vertebrate fauna of Chatham Island are certainly depauperate, but no exact figures can be given because the plants and animals occurring on the immediate adjacent mainland have not been documented. In view of the exposed nature of the island, the absence of eucalypts is not surprising. During the last glacial when sea-levels were 100 m lower than at present, Chatham Island would have been merely a prominent hill about 25 km from the ocean. At present Mt. Chudalup (185 m high) lies close behind Windy Harbour and the deep red loams around it support karri (*Eucalyptus diversicolor*) forest with its characteristic suite of plant species. Thus karri would conceivably have grown around Chatham Island on areas now covered by the sea. It is likely that Yate (*Eucalyptus cornuta*) and Bullich (*E. megacarpa*) occurred on the island.

The absence of various sea birds, in particular *Pterodroma macroptera* (Great-winged Petrel) and *Larus pacificus* (Pacific Gull) is remarkable. The absence of the former is interesting. On Eclipse Island (near Albany) in April 1975 (where two migratory seabirds, the Flesh-footed Shearwater and the Great-winged Petrel, occur) adult Shearwaters had ceased visiting the island. The Petrels had first arrived in March. On Chatham Island some adult Shearwaters were still visiting the island during May. On Sandy Island (50 km north-west of Chatham Island) Flesh-footed Shearwaters occur without *Pterodroma* and adults were noted by IA returning at night as late as April 1976. These facts seem to indicate a negative interaction, perhaps mediated through availability of burrowing space, between the two species on Eclipse Island.

The Cape Barren Goose, *Cereopsis novaehollandiae*, probably occurred on Chatham Island in the past as it formerly ranged as far west as Cape Leeuwin prior to the arrival of sealers and fishermen. Certainly the island appears suitable to support three or four pairs. It may be feasible to stock the island with several pairs from the Archipelago of the Recherche.

As Pied Cormorants are absent from the coastline near Chatham Island no trampling of the vegetation on the island is evident. Burrowing species of seabirds (Little Penguin, both Shearwater species) disturb the soil and manure it (Gillham 1963), and a peculiar vegetation pattern on the north side of the island may reflect past deleterious influences by the burrowing seabirds. Amongst the *Poa tussockland* there is a large strip of dead *Poa*, running from near sea-level to a height of c. 100 m. There was no evidence that this had resulted from fire.

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## Appendix

### Peat with profile development (Site No. 5)

Aspect: 330°.

Slope: 10°.

Height: 100 m.

Rock type: granite.

Vegetation: *Agonis marginata*, *Rhagodia*, *Boronia*, *Olearia*, *Chorilaena*, *Melaleuca microphylla*.

1. 0-2 cm Reddish black (7.5 R/1.7/1); loamy texture containing sand and plant litter; loose structure; gradual change to
2. 2-12 cm Reddish black (5 R/1.7/1); silty loam texture with sand grains; gradual change to
3. 12-25 cm Reddish black (2.5YR/1.7/1); sandy loam with occasional boulders; loose structure; gradual change to
4. 25-45 cm Dark reddish brown (7.5YR/3/2); indurated gravelly loam; gradual change to unweathered granite.
  - (a) pH 5.30 in horizon 1 with gradual increase to pH 5.55 in horizon 4.
  - (b) Increase in fine clay with depth.